Mechanism of early germination inhibition of fresh walnuts (*Juglans regia*) with gamma radiation uncovered by transcriptomic profiling of embryos during storage

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Abstract

Fresh walnut seeds are vulnerable to germination during room-temperature storage, which can be delayed or inhibited by gamma radiation. However, the inhibitory mechanism involves the expression of multiple genes and remains unclear. 'Liaohe 2' fresh walnut seeds were exposed to a wide-spectrum dose of 60Co gamma rays and then stored in sand under a suitable humidity at 25 ± 1 °C. Six transcriptome libraries of walnut embryos irradiated at 0 and 50 Gy were investigated at 0, 6 and 12 d of storage using RNA-seq. The results showed that a total of 177 differentially expressed genes (DEGs) was detected between the GR0d vs CK0d seeds. With gamma radiation, 471 genes were upregulated and 2835 genes could not be upregulated during the germination of untreated walnuts. Additionally, 1212 genes could not be downregulated, and 166 genes were downregulated. Glutathione and non-homologous end-joining were upregulated immediately after gamma radiation. In total, 23 upregulated genes related to reactive oxygen species (ROS) scavenging and signal transduction pathways were identified during early seed germination, and 79 genes related to ribosomal proteins could not be upregulated at 6 d after gamma radiation. The levels of both abscisic acid (ABA) and gibberellin (GA3) increased rapidly at 0 d, and the w(GA3)/w(ABA) ratio decreased significantly at 12 d after gamma radiation. In conclusion, a possible mechanism by which gamma radiation inhibits the germination of fresh walnuts was proposed as follows: gamma radiation first induced a series of stress responses, including the ROS scavenging system and TFs, and prevented the upregulated expression of ribosomal protein genes from 0 to 6 d, resulting in the inhibition of cell division, which is a likely key starting point for germination inhibition. Finally, a hormonal imbalance occurred, and the suppression of the upregulation of stored lipid breakdown genes from 6 to 12 d in treated nuts is proposed as the critical reason for the inhibition of fresh walnut germination by gamma radiation.